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Short Communication

Conception dates of Sika deer on the Boso Peninsula, central Japan

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The seasonal characteristics of mammalian reproduction are partly related to the seasonal dietary conditions of the species concerned (Lincoln 1985, Sadleir 1987, Bronson 1989). Birth and lactation of herbivores typically occur in spring in conjunction with the peak in available vegetation (Bronson 1989). Since this seasonal pattern of food availability varies with latitude, breeding seasons also vary with latitude in, for example, mountain sheep (Bunnell 1982), reindeer (Leader-Williams 1988) and deer of the genus *Odocoileus* (Bronson 1989).

The range of the Sika deer (*Cervus nippon* Temminck) extends along the Asian coastline of the Pacific Ocean from virtually the sub-tropical (14°N) to the sub-arctic regions (50°N) (Ohtaishi 1986, Whitehead 1993). As a consequence, the breeding season of this species is expected to differ at the different latitudes of the great length of its range. So far, however, details of the breeding season of Sika deer have only been reported from Hokkaido (43.5°N, Suzuki *et al.* 1996), Hyogo Prefecture (35°N, Koizumi 1991), and Nara Park (34.4°N, Miura 1984), and more wide-ranging researches are required to elucidate the situation more fully. Here we report an examination of the conception dates of Sika deer on the Boso Peninsula in central Japan (35°N).

Study Areas

The study area, of 124 km², ranges in elevation from sea-level to 300 m above sea level, consists of steep slopes, and is located in Chiba Prefecture, central Japan (35°N, 140°E, Fig. 1). The annual precipitation in the area is 2,000-2,400 mm, and the mean monthly temperature is about 4°C in mid-winter and 25°C in mid-summer (University of Tokyo 1988). The predominant vegetation of the area consists of evergreen broad-leaved forest, primarily *Machilus thunbergii* and *Castanopsis sieboldii,* natural coniferous forest consisting of *Abies firma* and *Tsuga sieboldii,* and plantations of two species of conifers, *Cryptomeria japonica* and *Chamaecyparis obtusa.*

In order to detect intra-population differences, the study area was divided

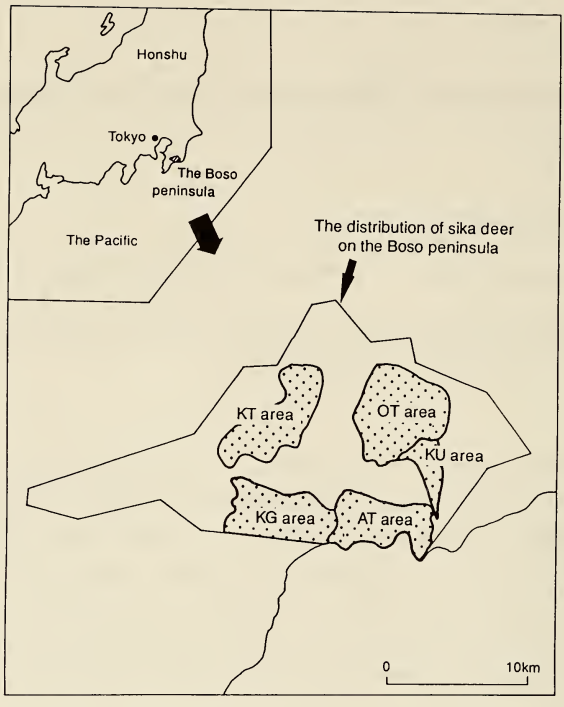

Fig. 1 Study area.

into five sub-areas according to deer density (Fig. 1) : the high density AT area where there were 22.4-37.9 deer/km², and the lower density KG, KU, OT and KT areas where there were : 14.7, 0.9, 1.1-5.7, and 6.7-8.4 deer/km², respectively (Chiba Prefecture and Deer Research Group on Boso 1993).

Materials and Methods

Female Sika deer on the Boso Peninsula are regularly culled, as a means of pest control. From such specimens we collected 180 fetuses in January and February 1993, February and March 1994, and February and March 1995. The ages of pregnant deer were determined by tooth replacement and by counting the cementum layers of the first incisors (Ohtaishi 1980).

The crown-rump length (CRL) of each fetus was measured to the nearest millimeter and the gestational age was estimated from the linear regression formula proposed by Koizumi (1991) :

$Y = 50.23 + 0.42X$

where X equals CRL (mm) and Y equals gestational age (days). This equation is based on a mean gestation period of 234 days and a body length at parturition of 440 mm as found for the deer population of the Tanzawa Mountains, central Japan (Iimura 1980). On the Boso Peninsula, the mean gestation period was found by Nakajima (1929) to be 235 days. The mean shoulder height ± *SD* of

adult females in the Tanzawa Mountains was 77.8 ± 6.7 cm (Iimura 1980) whereas on the Boso Peninsula it was 74.0 ± 3.8 cm (Ochiai and Asada 1995). Since the differences between these two populations were not large, we adopted Koizumi's (1991) model for the Boso Peninsula. The date of conception was estimated from the collection date and the gestational age.

Results and Discussion

Sika deer conceived between 8 September and 11 December, with a median date of 23-24 September, in all sub-areas of our Boso Peninsula study area. The crown-rump lengths of fetuses collected from the area ranged from 28 to 318 mm. In comparing the conception period on the Boso Peninsula with that of other populations (Fig. 2), it was found to be one month earlier than in Hokkaido, which is 10 degrees of latitude north of the Boso Peninsula (Suzuki *et al.* 1996), and was about 10 days earlier than in Hyogo Prefecture (35°N, Koizumi 1991).

The breeding season is later at more northerly latitudes in mountain sheep (Bunnell 1982) and in reindeer (Leader-Williams 1988), because it is related to phenological differences in dietary vegetation (Bunnell 1982). In reindeer populations, calving occurs one month earlier per 10 degrees higher latitude (Leader-Williams 1988), a relationship which is supported by our own study of Sika deer. The leaves of deciduous trees on the Boso Peninsula, common

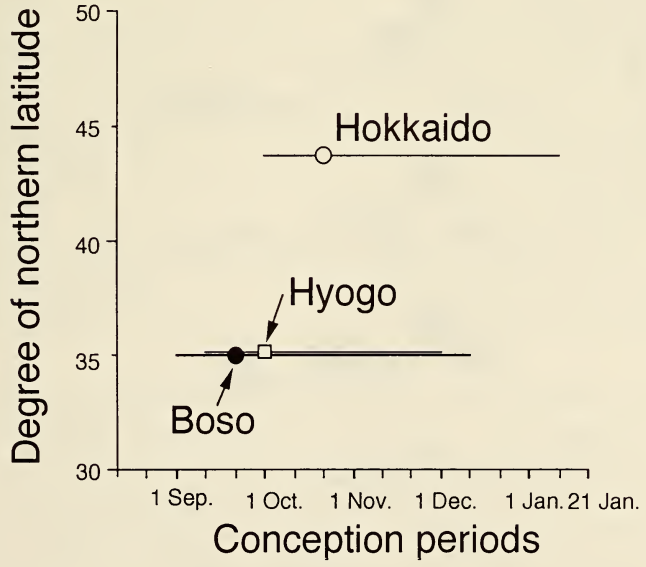

Fig. 2 Conception periods of Sika deer in Hokkaido, Hyogo and Boso. Bars show periods, and open circle, rectangle and solid circle indicates peaks of conceptions in Hokkaido, Hyogo and Boso, respectively. Data for Hokkaido and Hyogo are from Suzuki *et al.* (1996) and Koizumi (1991), respectively.

browse of the deer, begin to develop from early April to early May whereas in Hokkaido they develop from early May to mid May (Watanabe 1978, Sasaki 1983).

On the Boso Peninsula, local differences in the frequency distribution of conception were recognized from late October onwards (Fig. 3). During this period, pregnancy ratios were 16.7% in the KG, 19.2% in the KU, and 26.5% in the OT sub-areas, though only two deer (3.2%) were pregnant in sub-area AT, where deer density was high, and in sub-area KT, this tendency was not clear because of the small sample size.

In Nara Park, tame Sika deer at a high population density (276/km²)

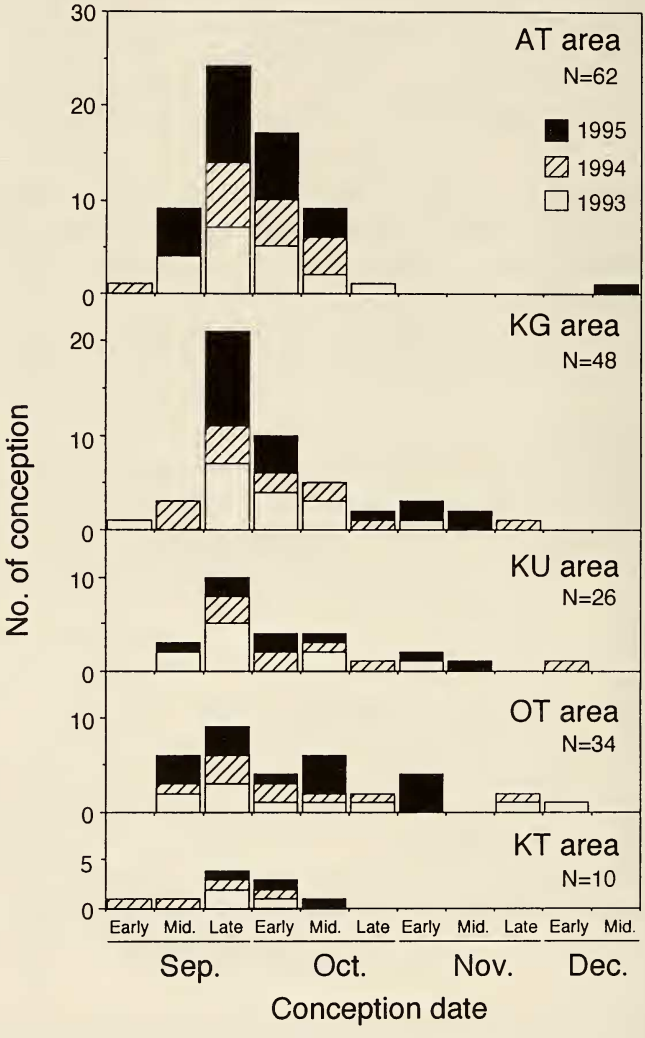

Fig. 3 Estimated distribution of conception date of Sika deer on the Boso Peninsula, central Japan. Samples were collected in January and February 1993, and February and March 1994 and 1995.

conceived synchronously (Miura 1984). Koizumi (1991) thought that such synchrony of conception was a consequence of gregariousness, a factor which also appears to be born out by our own observations from the Boso Peninsula.

Among Cervid deer, it is known that the conception rate, in any particular age class, is related to body weight during the rutting season. Thus, only deer above a specific body weight threshold can conceive (Mueller and Sadleir 1979, Hamilton and Blaxter 1980, Verme and Ullrey 1984, Sadleir 1987, Langbein and Putman 1992). Young deer conceive later than older deer, because they achieve this weight threshold later (Smith 1974, Hamilton and Blaxter 1980, Suzuki *et al.* 1996). To examine the relationship between the age of pregnant females and conception date, maternal age classes and conception periods were compared (see Table 1). Although four-year-old and older deer tended to conceive earlier than did younger deer, no significant difference was detected (χ^2-test ; $p>0.05$), *i. e.* the conception period appeared to be independent of maternal age on the Boso Peninsula. In Hokkaido, during the second half of the conception period, only 4% of two-years-old or older females were pregnant (Suzuki *et al.* 1996), whereas on the Boso Peninsula 13% of such young females from all five sub-areas, and 18% from four sub-areas, excluding the high density AT sub-area, were pregnant. Thus, it appears that conception among the two-year-old and older females is less synchronized on the Boso Peninsula than it is in Hokkaido. Since deer densities on the Boso Peninsula (with the exception of sub-area AT) and in Hokkaido were similar, at 5.0 ± 4.9 (mean± *SD*/km² n=10, Chiba Prefecture and Deer Research Group on Boso 1993) and 4.6 ± 4.9 (n=21, Hokkaido Institute of Environmental Sciences 1995), respectively, it is considered that this regional difference in conception synchrony was not due to differences of density.

We believe that this difference results from variation in the phenology of food plants used by the deer in different regions. It has been considered that the optimum periods for conception and parturition are affected by the periods of peak growth of the available vegetation (Bronson 1989). Bunnell (1982) showed that mountain sheep at more northerly latitudes began lambing later and lambed over a shorter duration than did sheep at more southerly latitudes, and that the timing of lambing was determined primarily by forage quality and quantity.

As mentioned above, spring leaf growth occurs approximately one month earlier on the Boso Peninsula than in Hokkaido. In Hokkaido, deciduous trees change color in autumn from late September onwards (Sasaki 1983), whereas they do so from mid-October onwards on the Boso Peninsula (Watanabe 1978). Furthermore, the first snows of winter occur from November onwards in Hokkaido, whereas little snow falls at all on the Boso Peninsula. Sika deer on the Boso Peninsula can continue to eat evergreen leaves from fall to winter (Asada and Ochiai 1996). Therefore, the duration of the optimum period for parturition seems to be longer, and synchrony seems to be weaker on the Boso Peninsula than in Hokkaido.

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